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15. Supplementary Notes

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16. Abstract (MAXIMUM 200 WORDS)

Laws designed to reduce the number of introductions of aquatic nuisance species into U.S. waters require ships from outside the Exclusive Economic Zone to conduct mid-ocean ballast water exchanges (BWE) before entering the Great Lakes and upper Hudson River. The National Invasive Species Act of 1996 requests ships entering any U.S. waters to conduct BWE. Because of low voluntary compliance, the U. S. Coast Guard recommended to Congress that BWE become mandatory in all waters.

When BWE becomes mandatory, the Coast Guard must have means to verify whether BWE occurred. Early research identified several potential characteristics of open ocean and coastal waters that might be used in verification. The Coast Guard sought standardized sampling and handling protocols such that multiple researchers could pursue this issue and have compatible results. This report provides protocols for sampling and handling colored, dissolved organic matter, trace metals, and radium. It gives an overview of the parameters, discusses sampling apparatus and specifications, provides detailed protocols, and explains sample storage prior to shipment. It addresses contamination, representative samples, obtaining blanks, sampling over-the-side, and standardization.

Information obtained using these protocols will allow better characterization of open ocean and coastal water, and will enhance the Coast Guard's ability to verify BWE.

17. Key Words	18. Distribution Statement
protocol, ballast water exchange, verification, mid-ocean, trace metals, colored dissolved organic matter, radium	This document is available to the U.S. public through the National Technical Information Service, Springfield, VA 22161

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Executive Summary

In 1990 Congress passed the Nonindigenous Aquatic Nuisance Prevention and Control Act (NANPCA) in an effort to slow the introduction of Aquatic Nuisance Species (ANS) into the Great Lakes and the upper Hudson River. Under NANPCA, ships entering these waters were required to conduct a mid-ocean ballast exchange (or use an equivalent treatment) such that any water released during deballasting would be oceanic rather than coastal. The Coast Guard was tasked with enforcing that requirement and routinely uses salinity readings to verify that ballast water exchange (BWE) has been carried out. Currently, a salinity determination of 30 parts per thousand is used as the indicator of an acceptable exchange.

In 1996, Congress reauthorized NANPCA with the National Invasive Species Act (NISA) and expanded Coast Guard's area of ANS concern to include all U. S. waters. Under NISA, ships entering any U. S. port, other than the areas delimited by NANPCA, are requested to carry out BWE and are required to submit information on their ballast water management practices. After two years of collecting data from mandatory reports, it was found that only 30.4 percent of ships even filed reports and approximately 51.2 percent of those actually performed the BWE. The Coast Guard has therefore recommended to Congress that BWE become mandatory for all ships entering U. S. waters from beyond the Exclusive Economic Zone.

BWE and holding ballast onboard are the two most common ballast management practices today. At present, BWE is verified using the 30 parts per thousand salinity criterion even though it is recognized that this is insufficient to verify exchange if the original ballasting took place in high salinity ports. With the recommendation that BWE become mandatory for all ships comes the requirement to be able to differentiate between exchanged and unexchanged water in ballast tanks. In effect this means distinguishing between open ocean and coastal water. An initial study solicited recommendations from a panel of experts for parameters that varied from coastal waters to offshore waters. At-sea investigations of the most promising parameters led to the identification of several parameters that, when combined with salinity, could potentially identify water as either open ocean or coastal.

To augment the initial findings, a second study was initiated. Part of that study included solidifying the sampling and handling protocols for these parameters. The protocols presented in

this document are the result of those two studies. It is recognized that coastal and open ocean waters are highly variable, both temporally and geographically. Likewise, the expense in both time and money of obtaining sufficient coastal and ocean samples to fully characterize the distribution of parameters is prohibitive for a single agency. The use of standardized protocols and analysis procedures by multiple nations and agencies will help provide sufficient data to define the parameter distribution. When these parameters are coupled with salinity, a determination of BWE can be made.

The goal of this document is to provide background information and specific protocols to allow researchers worldwide to plan for and obtain samples to describe the characteristics of water masses where ballast water might be taken up or exchanged. The potential for contamination from both the ship and the sampling and storage equipment is discussed. The suitability of different materials for contact with the selected parameters (colored dissolved organic matter, trace metals, and radium) is provided to allow selection of appropriate equipment. Suggestions for equipment include descriptions of pumps, water sampling devices, profiling equipment, filters, and specialized rosin cartridges. Access to ballast tanks is discussed along with precautions to be taken when profiling or sampling tanks.

For each of the parameters (salinity, colored dissolved organic matter, trace metals, and radium), a specific protocol is presented. Each includes a brief overview of the parameter, a description of the sampling apparatus, a description of the sample to be obtained, a brief summary of laboratory preparation of the sample devices and sample containers, a step-by-step procedure for shipboard sampling, examples of logbook entries, and handling and treatment procedures for getting the samples to the laboratory. In addition, protocols for obtaining blanks are provided. Methods for obtaining over-the-side samples are also discussed.

The ultimate Coast Guard goal is the ability to verify that a ship has indeed conducted a ballast water exchange in mid-ocean. The information presented in this document should be sufficient for researchers to replicate the methodology already in use, which in turn will allow comparisons of data from very different geographical and water quality regions to existing data. This will aid in the characterization of coastal water differences from open ocean water, and this characterization will lead to the Coast Guard's goal. The protocols themselves will have to be modified before they can be used for Coast Guard enforcement operations.

Finally, it is recognized that the protocols presented in this document are subject to change as methodologies and technologies improve. They do, however, form a framework upon which new methodologies can build. The protocols presented here are therefore considered as Version 1 of an evolving research effort.